FS Future Series®

GeoSeeker

User's Manual

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Chapter 1

Introduction

1.1 Preface

Dear Customer,

first of all we would like to thank you in choosing a product manufactured by OKM. The present product is based on a geoelectrical measuring method utilizing the Schlumberger technique to measure the resistivity of different soil layers.

With our team of specialists we guarantee that our products are under recurrent control. Our specialists are constantly implementing new developments in terms of further quality improvements for you. Of course by selling our products we cannot guarantee that you will make a find during your research. The recognition of hidden structures depends on a huge number of factors – as you are already aware of. Determining factors like the dielectric constant of the ground, the grade of mineralization and the conductivity of different soils. Especially in very wet soils like clay and sand with high conductivity or attenuation of the ground. In certain conditions recording of the measured results can be falsified strongly.

For more information regarding where this equipment has been used and operated, please visit our web site. Our equipment is constantly being tested and when improvements or upgrades are available, we will list them also on our web site.

It is necessary for our company to protect our developments and all of the information learned during the “Research and Development” phases in creating our technology. We strive to stay within the given framework of legislation, patents and trademark registration.

Please take the time to read this User Manual and familiarize yourself with the operation, functionality and how to utilize the GeoSeeker. We also offer training for your equipment in our factory. We strive to maintain a worldwide dealer network for assistance and support. Please visit our web site for more information.

1.2 Important Notes

Prior to using the GeoSeeker and its accessories, please read these operating instructions carefully. These instructions give information on how to properly use this geoelectrical detector and shows potential sources where precautions should be taken.

1.2.1 Security Guidelines

The GeoSeeker has a maximum output of 390 V and 0.5 A even if it is not present at all times. But under some circumstances the maximum output can be present at the electrodes of the GeoSeeker. Therefor you have to take special care when handling the electrodes:

- Do not touch any of the electrodes when measuring is in progress.
- Before replacing any of the electrodes unplug the connecting cable to isolate the electrodes from active power supply.
- Do not initiate any measuring as long as someone is handling the electrodes.
- Instruct all your helpers and assistants concerning these security guidelines to avoid unnecessary injuries.

1.2.2 General Notes

Being an electronic device, the GeoSeeker has to be treated with caution and care as with any electronic device. Any failure to observe the safety precautions given or any use for purposes other than the ones it is designed for may result in damage or destruction of the processing unit and/or its accessories or connected components.

The device has a built in anti-tampering module which will destroy the unit if it is improperly opened. There are no end user serviceable parts on the inside of the unit.

1.2.3 Surrounding Area

When moving this unit from a cold place to a warmer place, watch out for condensation. Do not immediately operate the unit until any possible condensation has evaporated. The unit is not weather proof and water, moisture or condensation can destroy the unit.

Avoid strong magnetic fields, which may occur in places where there are large electric motors or unshielded loudspeakers. Try to avoid using this equipment if someone else is using this type of equipment closely.

Avoid using this equipment around active military installations and airports or where there may be other devices that may hamper the signals received. Radars for aircraft, boats and weather reporting may lower the units capabilities.

1.2.4 Voltage / Power Supply

The power supply should not be outside the indicated range of values. Use only approved chargers, batteries and rechargeable batteries which are included in the scope of delivery. Only use the recommended type of batteries or rechargeable batteries as indicated in this user's manual.

1.2.5 Maintenance and Services

In this section you will learn how to maintain your measuring instrument with all of its included accessories. This will keep it in good condition a long time and you will be able to get good measuring results.

The following list indicates what you absolutely should avoid:

- penetrating water
- strong dirt and dust deposits
- hard impacts
- strong magnetic fields
- strong microwave fields
- high and long lasting heat effect

To clean your device please use a dry soft cloth. To avoid any damage you should always transport the device and accessories in the appropriate carrying cases.

Prior to using your GeoSeeker please be sure that all batteries and accumulators are fully charged. Also allow the batteries to completely discharge before recharging them, regardless if you are working with the external battery or with internal accumulators. This way your batteries will have a long and durable life.

1.2.6 Danger of Explosion during Excavation

Unfortunately, the last two world wars also made the ground in many places of the world a potentially explosive scrap heap. A host of those lethal relics are still buried in the ground. Do not start digging and hacking for an object wildly when you receive a signal of a piece of metal from your device. Firstly, you might indeed cause irreparable damage to a truly rare find, and secondly, there is a chance that the object reacts in an insulted way and strikes back.

Note the color of the ground close to the surface. A red or reddish color of the ground is an indicator of rust traces. As regards to the finds themselves, you should definitely pay attention to their shape. Curved or round objects should be a sign of alarm, especially if buttons, rings or little pegs can be identified or felt. The same applies to recognizable ammunition or bullets and shells. Leave that stuff alone and where it is, do not touch anything and, most importantly, do not take any of those items home

with you. The killing machines of war made use of many diabolical inventions such as rocker fuses, acid fuses and ball fuses. Those components have been rusting away in the course of time, and the slightest movement may cause parts of them to break and be triggered. Even seemingly harmless objects such as cartridges or large ammunition are anything but that. Explosives may have become crystalline over time, that is, sugar-like crystals within them have formed, they are still dangerous and should be regarded as a potential killer.

Moving such an object may cause those crystals to produce friction, leading to an explosion. If you come across such relics, mark the place and do not fail to report the find to the police or proper authority. Such objects always pose a danger to the life of hikers, walkers, farmers, children and animals.

Chapter 2

Technical specifications

The following technical indications are medial values. During operation small variations are quite possible. Technical changes due to development are also possible.

2.1 Controller (Receiving Unit)

Dimensions (H x W x D) ..... 130 x 270 x 110 mm
Weight ..... 0.6 kg
Weight (with mounted cable drums and batteries) ..... 2.1 kg
Power Supply (8 AA batteries) ..... 8 – 14 VDC[1]
Operating Time (charged batteries) ..... min. 16 hours
Charging Time (empty batteries) ..... typically 3 hours, max. 5 hours
Input (Charger) ..... 12 VDC, 1.5 A
CPU ..... 80 MHz Cortex M3
ADC ..... 16 bit
Communication with Tablet PC ..... WLAN-Accesspoint, 2.4 GHz band, channel 6, WPA2
Communication with Power Box ..... 2.4 GHz band, on-demand, proprietary
Effective Range (differential) ..... -1400 to +1400 mV
Input Resistance (static) ..... approx. 12 MΩ
Data Sampling Rate ..... 4096 Hz (64 times oversampling of a 512 samples mean value)
Measurement Period per Scan Point ..... min. 16 seconds

2.2 Power Box (Sending Unit)

Dimensions (H x W x D) ..... 230 x 550 x 360 mm
Weight ..... 15.8 kg
Weight (with mounted Electrodes) ..... 18 kg
Internal Power Supply ..... Lead Acid Battery (2 x 12 V, 10 Ah)
Output ..... max. 390 V, 0.5 A, 20 W
Operating Time (min. Power) ..... approx. 100 hours
Operating Time (average Power) ..... approx. 40 hours
Operating Time (max. Power) ..... approx. 8 hours
Charging Time ..... max. 8 hours
Input (Charger) ..... 24 VDC, 2 A
Communication with Controller ..... 2.4 GHz band, on-demand, proprietary

2.3 Electrodes

Dimensions (L x W x D) .....440 x 120 x 35 mm
Weight ..... 0.52 kg

1 Equates 8 AA batteries; Use only boost chargeable NiMh batteries or primary cells with a minimum capacity of 2000 mAh; Do not use other kind of batteries with the supplied charger (danger of explosion);

2.4 Cable Drums

2.4.1 Power Drum (Ø 290 mm)

Dimensions (H x W x D) ..... 360 x 290 x 200 mm
Weight ..... 6.5 kg
Cable Length ..... 255 m
Markers 15

2.4.2 Voltage Drum (Ø 120 mm)

Dimensions (H x W x D) ..... 120 x 120 x 45 mm
Weight ..... 0.65 kg
Cable Length ..... 26 m
Markers 25

2.5 Tablet PC, Minimum requirements

Operating System ..... Android 4.4.2 or higher
Wi-Fi / WLAN ..... Required
USB Chargeable ..... Micro-USB-B
Display ..... 7” Tablet Screen, Outdoor Brightness

Chapter 3

Scope of delivery

In the following section you can find all standard equipment and optional parts of the GeoSeeker.

Description	Quantity
Controller	1
Power Box (carrying case)	1
Power Cable Drum (290 mm cable drum)	2
Voltage Cable Drum (120 mm cable drum)	2
AA batteries, rechargeable	8
Tablet Holder	1
Android Tablet PC	1
User manual	1
Extension cable, 2 m	2
Charger for Controller	1
Charger for Power Box	1
Electrode	4
USB Power Pack with charger and travel adapter	1

Table 1: Scope of delivery

Chapter 4

Control elements

In this section you will learn more about the fundamental use of all control elements for this measuring instrument. All connections, inputs and outputs are explained in detail.

4.1 Electrodes

There are 4 electrodes in total, 2 electrodes with a red socket (Power Electrodes) and 2 electrodes with a black socket (Voltage Electrodes).

Figure 4.1: Elements of the electrodes

Handle / Shaft: Use the handle to push the electrode's shaft into the underground as deep as possible. You may use a hammer to do so. The shaft is made of stainless steel to be robust against moisture and weird soil conditions.

Socket: The socket is used to connect the cables whereas the red socket is used for the power injection and the black socket is used for measuring the voltage.

4.2 Cable Drums

There are 4 cable drums on the whole, 2 big ones and 2 small ones. The big cable drums – referred to as “Power Cable Drums” – are used to connect the Power Electrodes (electrodes with red socket) with the Power Box, whereas the small ones – referred to as “Voltage Cable Drums” – are used to connect the Voltage Electrodes (electrodes with black socket) with the Controller.

4.2.1 Power Cable Drums (Ø 290 mm)

The two larger cable drums – also called “Power Cable Drums” – are the link between the Power Box and the Power Electrodes.

Figure 4.2: Elements of the power cable drums

Socket Connector for Extension Cable: This socket is used to connect the extension cable and link it to the power electrode.

Plug Connector: Put the plug connector into the left or right socket of the Power Box.

Marker: The cable of each drum is labeled with 15 markers in total. This markers are numbered from 1 to 15 and will help you to place the electrodes at the right position during the measurement.

4.2.2 Voltage Cable Drums (Ø 120 mm)

The two smaller cable drums – also called “Voltage Cable Drums” – are the link between the Controller and the Voltage Electrodes.

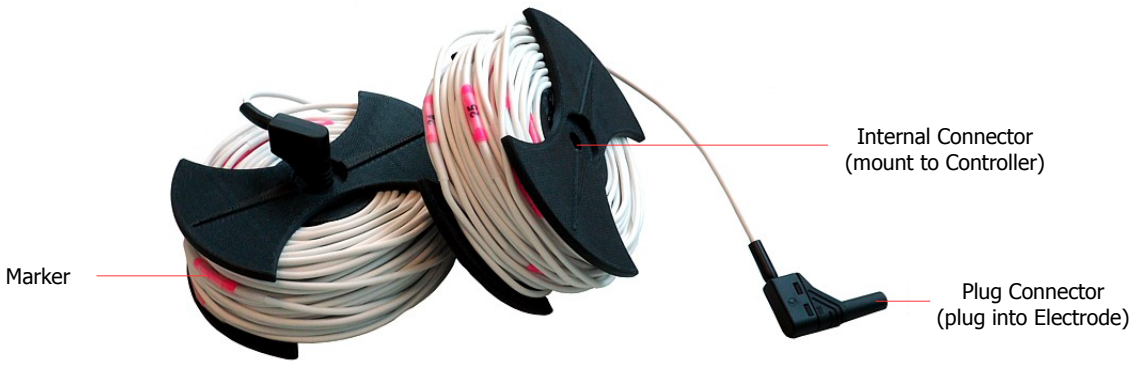


Figure 4.3: Elements of the voltage cable drums

Internal Connector: When mounting the small cable drums to the Controller the internal connectors are establishing electrical contact with the electrical connectors of the Controller. Please make sure that these connectors are very clean when attaching the cable drums.

Plug Connector: The plug connector needs to be plugged into the Voltage Electrode.

Marker: The cable of each drum is labeled with 25 markers in total. This markers are numbered from 1 to 25 and will help you to place the electrodes at the right position during the measurement.

4.3 Controller

The Controller is responsible to measure the voltage between the measure electrodes. Figure 4.4 shows all control elements of the Controller.

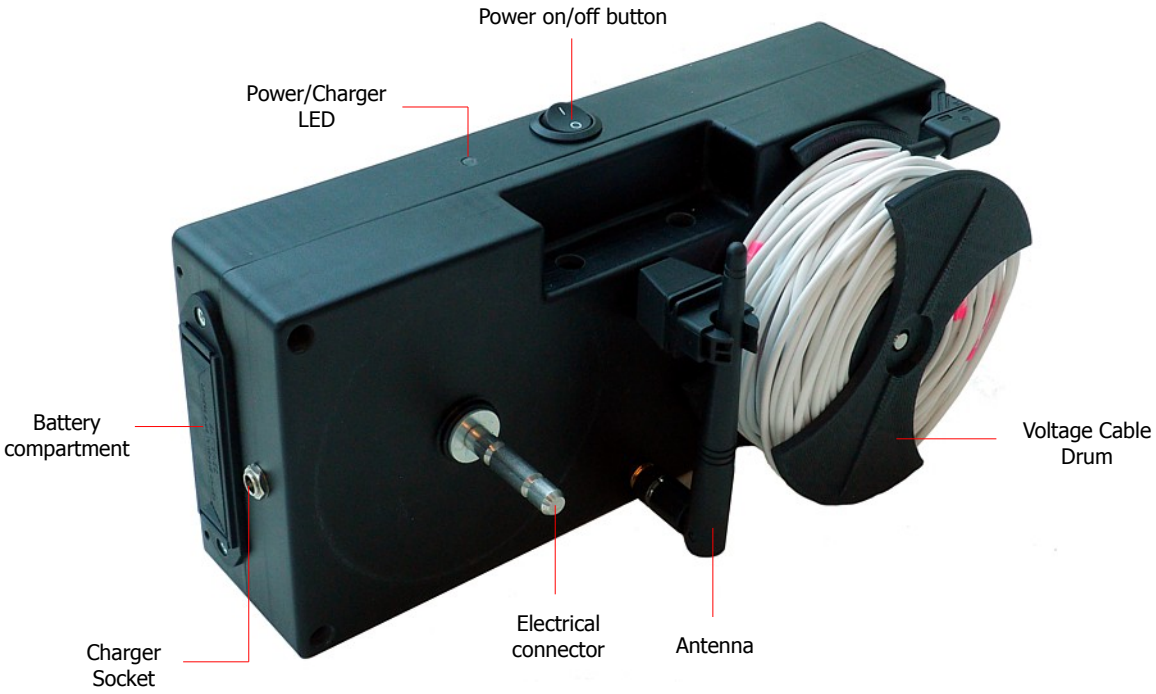


Figure 4.4: Control elements of the Controller

Power on/off button: Use the power on/off button to power your Controller on and off. In case of any critical situation you can switch off your device at any time. The functionality of the device will not be affected.

Power/Charger LED: After powering on the Controller the Power/Charger LED will first shine in a blue color until the device is ready for operation. Then it will shine in a color indicating the current charge condition of the internal batteries. Green indicates a charge of more than 40 %, yellow a charge of more than 20 % and red anything below. You should recharge the batteries latest when the Power/Charger LED is red to make sure you have enough power for your next measurement.

Charger Socket: Use the charger socket to connect your 12 V battery charger. Before using the charger ensure that only rechargeable batteries are placed into the battery compartments. Depending

on the current charge condition of the batteries the charging process can take up to 5 hours. Alternatively you can just replace the batteries with fresh ones.

Battery Compartments: There are two battery compartments for a whole of 8 AA batteries. Please pay attention to place the batteries in the right order as indicated on the compartment.

Antenna: The antenna is used to establish and maintain a good wireless data connection between Controller and Power Box. You should raise it up for better connection quality.

Electrical Connector / Small Cable Drum: There are two small cable drums which can be mounted to the electrical connectors of the Controller. These Voltage Cable Drums are used to connect the Controller with the two Voltage Electrodes (electrodes with red socket).

4.4 Tablet Holder

The tablet holder is used to mount a Tablet PC on top of the Controller. So you can either put the controller onto the ground for operation or you simply carry the Controller around your neck.

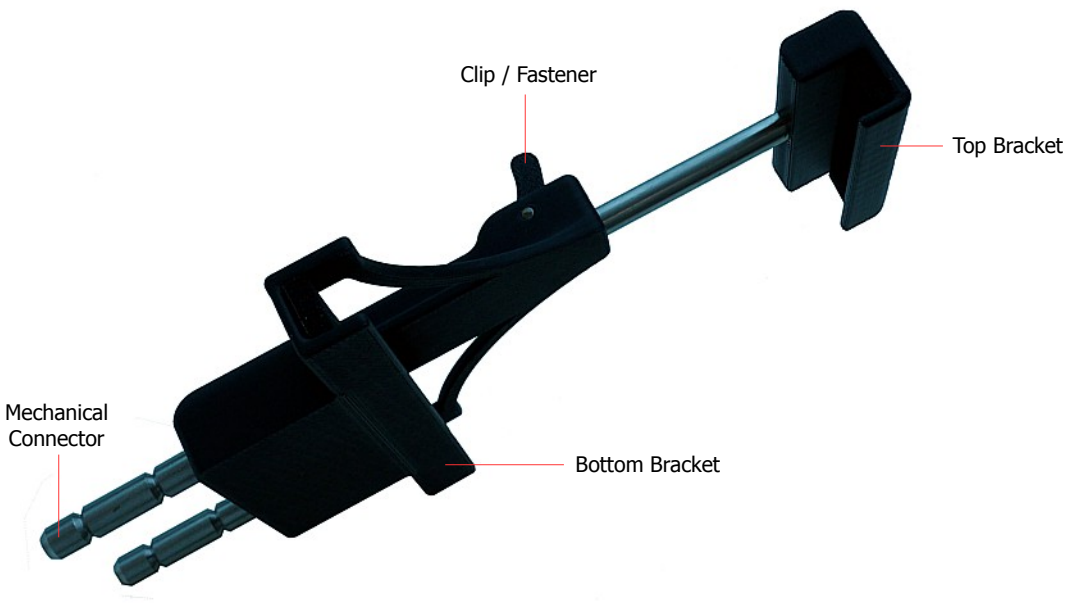


Figure 4.5: Elements of the tablet holder

Clip/Fastener: Use this clip to loosen or tighten the top bracket of the Tablet Holder. This bracket will push the Tablet PC into the bottom bracket to keep it in place. As soon as the Tablet PC is fixed between the brackets lock the clip.

Mechanical Connectors: You can mount the Tablet Holder to your Controller by pushing the metallic connectors into the appropriate holes at the top of the Controller.

Top Bracket / Bottom Bracket: These two brackets keep the Tablet PC in place after tighten the Clip.

4.5 Power Box

The Power Box is used to inject electrical power into the underground which could be measured by the Controller afterwards. Figure 4.6 shows all the control elements of the Power Box.

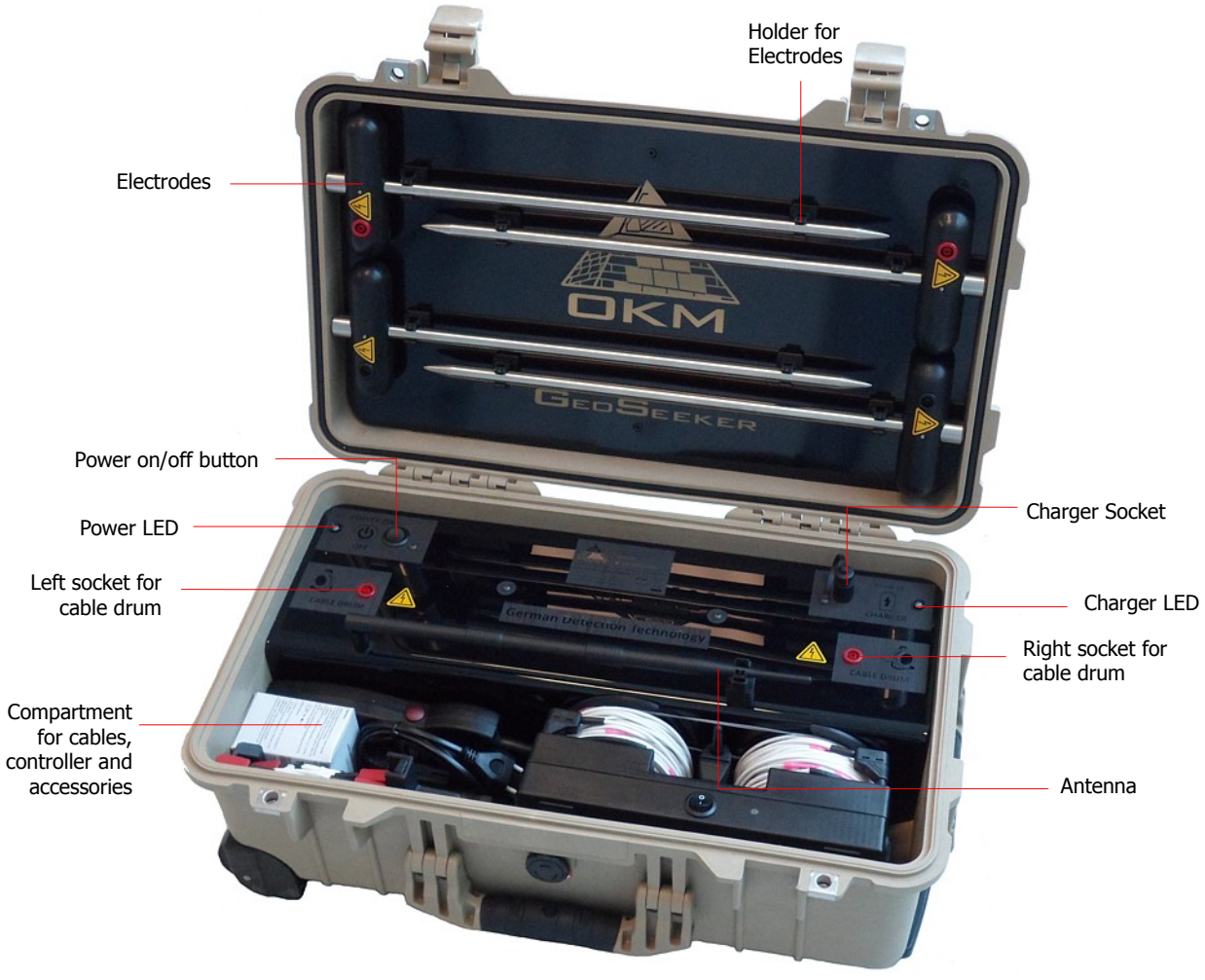


Figure 4.6: Control elements of the Power Box

Power on/off button: Use the power on/off button to power your Power Box on and off. In case of any critical situation you can switch off your device at any time. The functionality of the device will not be affected.

Power LED: After powering on the Power Box the Power LED will first shine in a blue color until the device is ready for operation. Then it will shine in a color indicating the current charge condition of the internal batteries. Green indicates a charge of more than 40 %, yellow a charge of more than 20 % and red anything below. You should recharge the internal batteries latest when the Power LED is red to make sure you have enough power for your next measurement.

Charger Socket: Use the charger socket to connect your 24 V charger. Depending on the current charge condition of the internal batteries the charging process can take up to 8 hours.

Charger LED: The Charger LED represents the current charge condition of your internal batteries. As long as the Charger LED is shining red the charging process is still in progress. As soon as the LED turns green your internal batteries are fully charged.

Sockets for Cable Drum: Use these sockets to plug in the connectors of the Power Cable Drums. These are the output sockets for the power injection while conducting active measurements.

Antenna: The antenna is used to establish and maintain a good wireless data connection between Power Box and Controller. You should raise it up for better connection quality.

Compartment: The compartment is used to store the Controller and all kind of accessories like extension cables, chargers, Power Pack as well as the tablet holder.

Electrodes: The electrodes are stored in the top of the carrying case by clipping it into the designated clips. There are two Power Electrodes with a red socket as well as two Voltage Electrodes with a black socket. The Power Electrodes are used to inject power - generated by the Power Box - into the ground. The Voltage Electrodes are used to measure the voltage of the underground utilizing the Controller.

Chapter 5

Android Application

In this section is explained how to prepare your Tablet PC with the Android application.

If you purchased the complete package of the GeoSeeker, the Tablet PC is included and already prepared with an activated application. In that case you can skip the first 2 sections of this chapter and continue reading with section “Operating modes and functionality“ on page 29.

5.1 Download & Installation

If you want to reinstall the application after a factory reset or you want to install it to another Tablet PC you have to download the application from “Google Play” first.

Find the “Play Store” application on the Tablet PC where you are going to install the GeoSeeker application and tap on it. If you don't have any Google Account so far, you must create one to be able to download the GeoSeeker application. Simply follow the instructions on your Tablet PC to download and install the application.

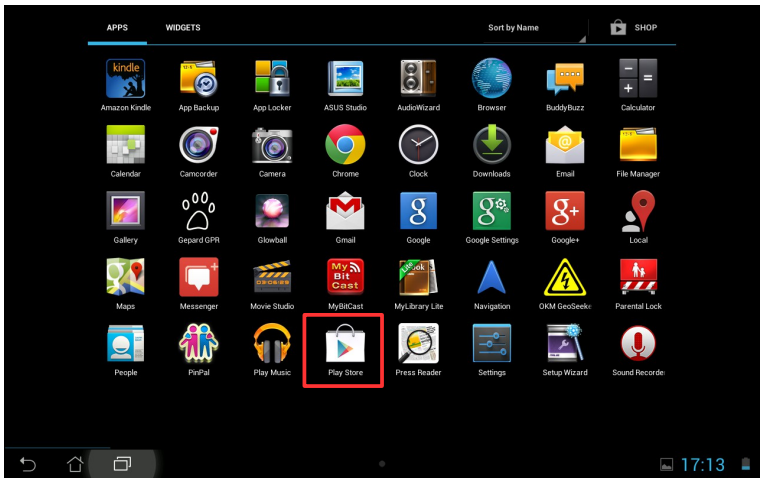


Figure 5.1: Installation of the application via Google Play Store

After installation you have to activate both the Controller and the Power Box. Detailed information about the activation process you can read in chapter “5.2.4 Activation” on page 36. In case of any troubles please contact your local dealer for additional help!

5.2 Operating modes and functionality

After starting your GeoSeeker application you will see the main menu as shown in figure 5.2.

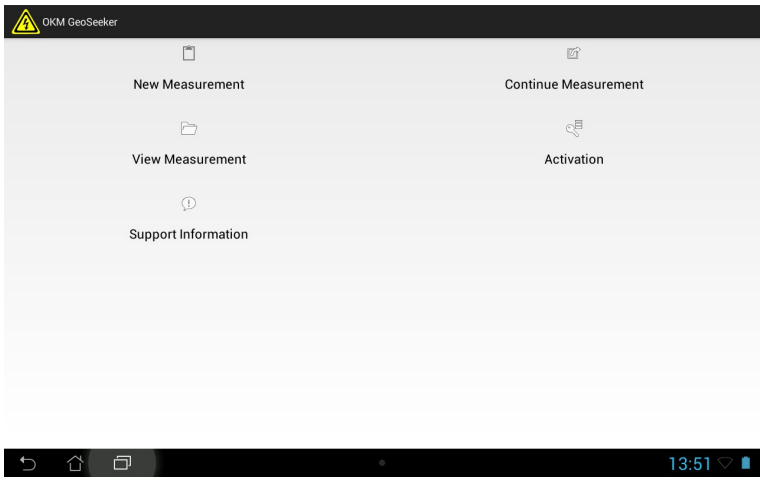


Figure 5.2: Application's main menu

The following options are available:

- **New Measurement**
  Select this option if you want to conduct a new measurement. You will have to follow some additional steps to set up the depth range and field dimensions of your new measurement.
- **Continue Measurement**
  If you have already started a new measurement some time ago but not finished you may select it here and continue the scan.
- **View Measurement**
  You can select a finished measurement or even an unfinished one to view its graphical 3d representation.
- **Activation**
  Use this option to renew the activation of your Controller and your Power Box. Without a proper activation you will not be able to use the GeoSeeker properly. After purchasing the complete package with Tablet PC everything is already set up properly and ready to go.
- **Support Information**
  On this screen you will find the contact details for OKM as well as the current firmware version of your equipment.

5.2.1 New Measurement

This is the option of your choice if you are going to create a new measurement. There are several options to choose and depending on your preferred scan mode the creation process is slightly different as shown in figure 5.3.

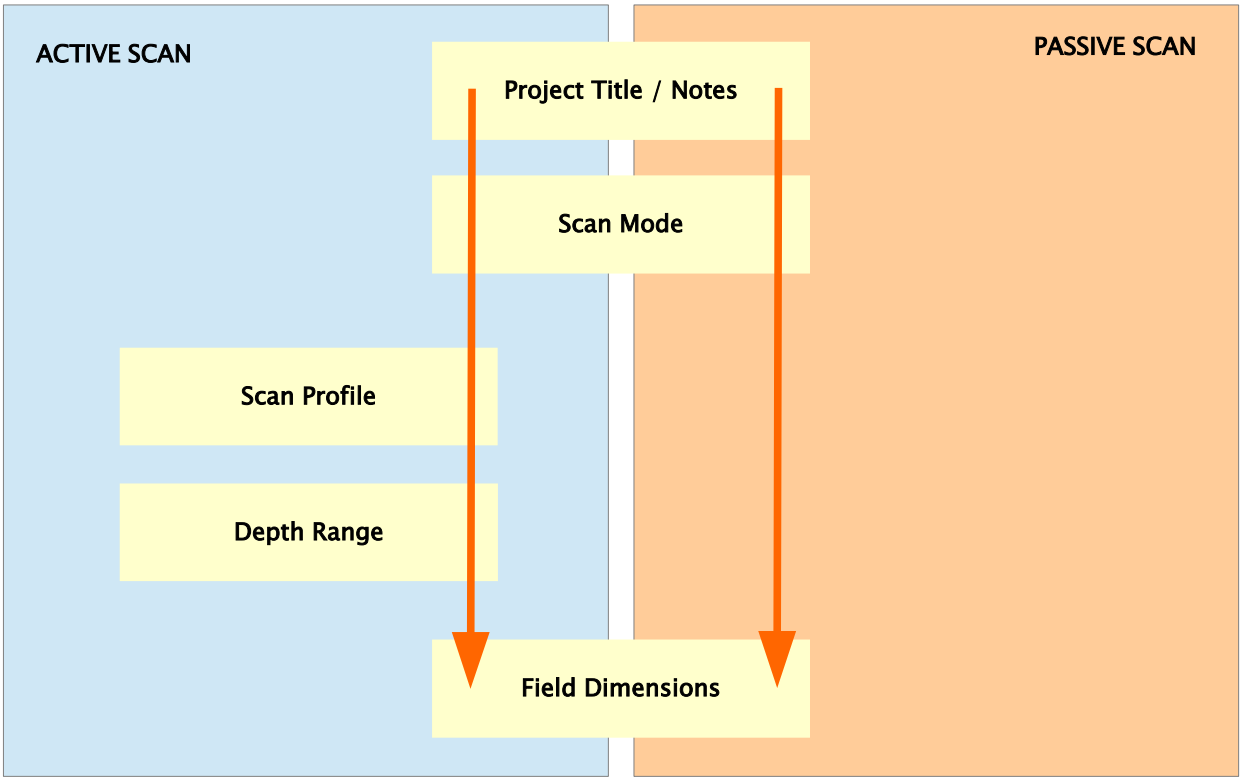


Figure 5.3: New Measurement - Creation process

After selecting the option "New Measurement" you have to enter a specific project title. Additionally you may add some further notes concerning your current project (e.g. workers involved, GPS coordinates, ground conditions, field information etc.).

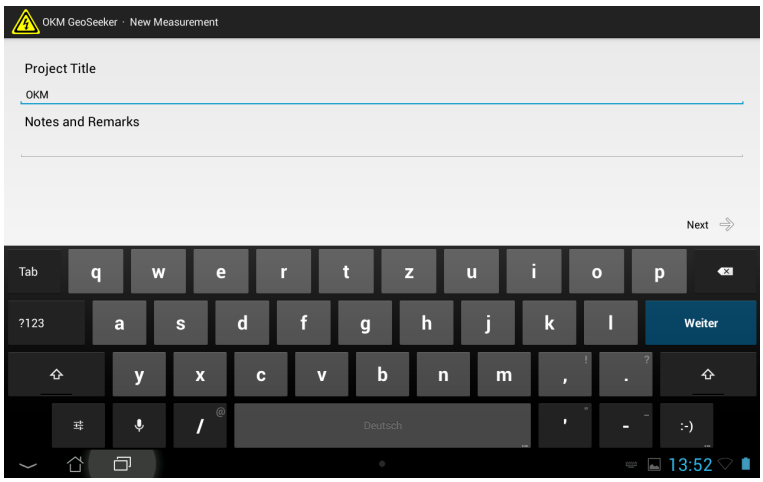


Figure 5.4: New Measurement - Project title / notes

You cannot continue without entering any title. This project title should be unique so you can easily browse your measurement out of others. After typing your title tap on "Next" to select your preferred scan mode.

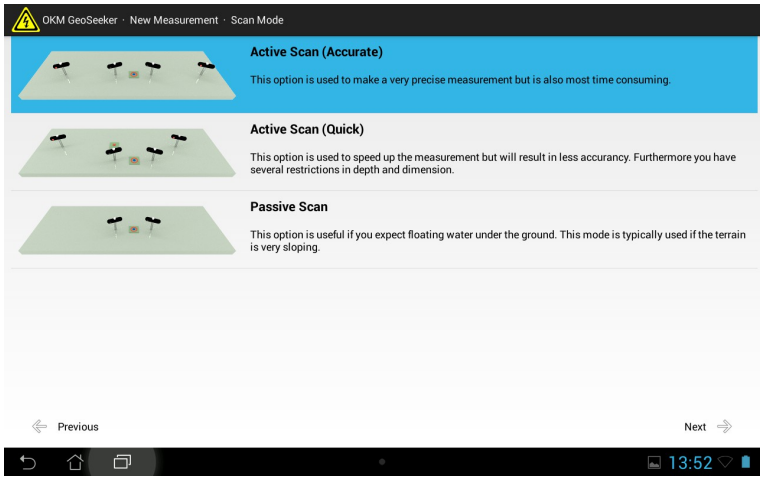

OKM GeoSeeker · New Measurement · Scan Mode
Active Scan (Accurate)
This option is used to make a very precise measurement but is also most time consuming.
Active Scan (Quick)
This option is used to speed up the measurement but will result in less accurancy. Furthermore you have several restrictions in depth and dimension.
Passive Scan
This option is useful if you expect floating water under the ground. This mode is typically used if the terrain is very sloping.
Previous
Next
13:52

Figure 5.5: New Measurement - Scan mode

Now you can select one of the following scan modes:

- Active Scan (Accurate)
- Active Scan (Quick)
- Passive Scan

First tap on the scan mode you want to use and then tap onto “Next”. Further explanations concerning the scan mode you will find in chapter “7 Conducting a measurement“ on page 47.

If you have selected one of the active scan modes you have to select a certain scan profile, which sets up a basic scanning theme. In case you have selected the passive scan mode this step will be skipped and you will continue with entering the field dimensions.

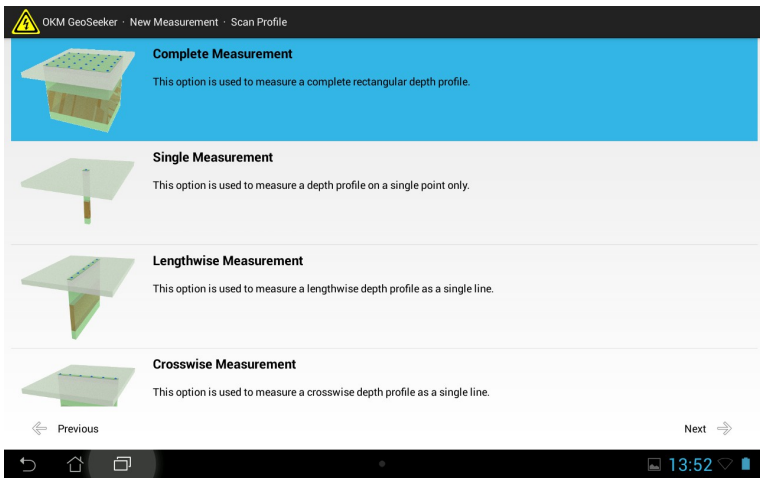

OKM GeoSeeker · New Measurement · Scan Profile
Complete Measurement
This option is used to measure a complete rectangular depth profile.
Single Measurement
This option is used to measure a depth profile on a single point only.
Lengthwise Measurement
This option is used to measure a lengthwise depth profile as a single line.
Crosswise Measurement
This option is used to measure a crosswise depth profile as a single line.
Previous
Next
13:52

Figure 5.6: New Measurement - Scan profile

After selecting an active scan mode there are following scan profiles available:

- Complete Measurement
- Single Measurement

- Lengthwise Measurement
- Crosswise Measurement

First tap on the scan profile you want to use and then tap onto “Next”. Now you have to select the depth range (starting depth and ending depth) of your measurement. If you can limit your depth to a very small range your measurement will be finished much faster than measuring all available depth steps.

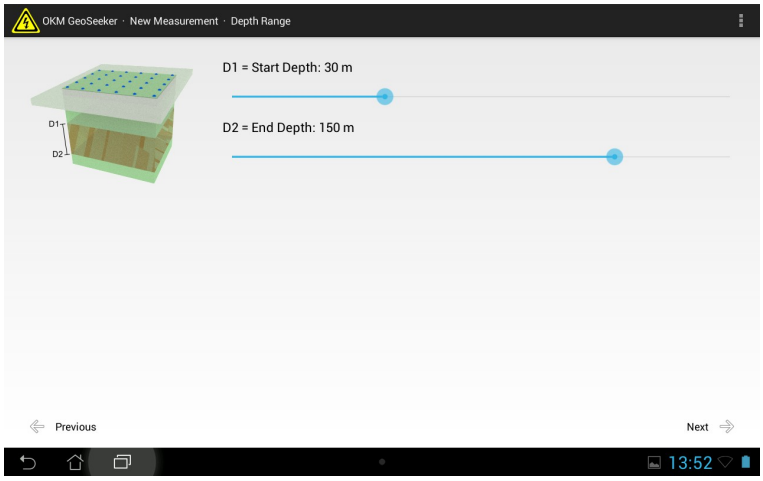


Figure 5.7: New Measurement – Depth settings

After you have entered your preferred depth range information tap on “Next”. The last step of setting up a new measurement is to adjust the field dimensions (field length and width) as well as the distance between the scan points (resolution).

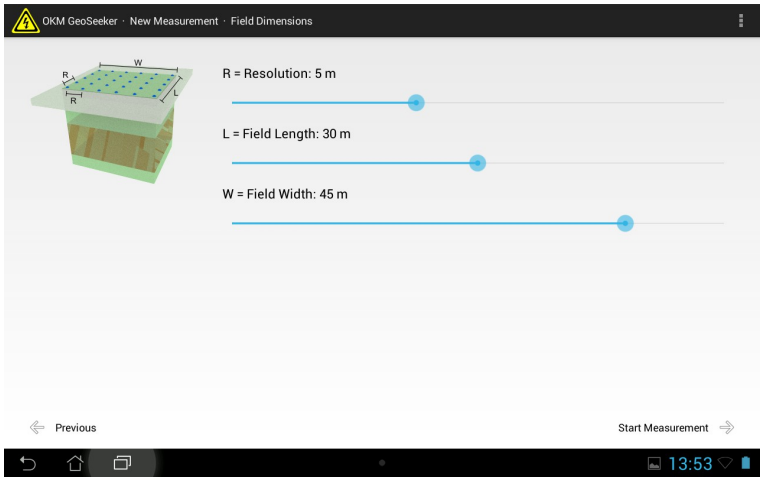


Figure 5.8: New Measurement - Field dimensions

This step is necessary for all active scan modes as well as the passive scan mode. First you select your resolution, which is defined as the distance between your scan points. Afterwards you adjust the length and width of your scan field.

This information is also very important to physically mark your scan points outside. Detailed information concerning the preparation of your scan field you can read in chapter “7 Conducting a measurement“ on page 47.

Finally you will see the screen from figure 5.9 where you can see how to set up all your electrodes. Just read the information shown on this screen and prepare all your equipment according to it.

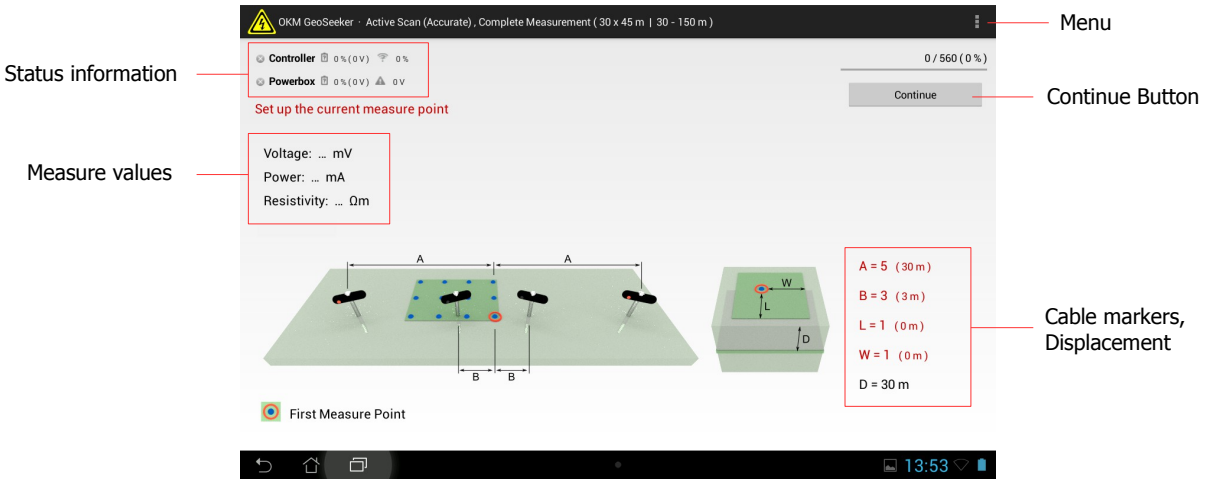


Figure 5.9: New Measurement - Arrangement of electrodes

Status information: Here you can see the current operating state of your Power Box and Controller as well as the current battery status.

Continue Button: After setting up your equipment according to the displayed instructions you tap on this button to run a new measuring at the current scan point.

Measure Values: After measuring a scan point you will see the results immediately displayed on the screen. The available measure values depending on the selected scan mode are:

- Active measurement: Voltage, Power and Resistivity
- Passive measurement: Voltage

Menu: Click on this menu button to change your units between meters (m) and feet (ft). This menu button can be located at very different positions depending on your current Tablet PC or Android version.

Cable Markers, Displacement: This is the place where you get proper information about the next scan point (the scan point which will be measured after tapping the “continue” button). There is always an indication of the cable marker where your electrode needs to be placed into the ground as well as the final distance between Power Box or Controller in meters or feet.

If the number is written in red color than this value has changed in relation to the previous scan point.

There are following letters and meanings:

- **A** ... is the distance between left Power Electrode and Power Box as well as the distance between Power Box and right Power Electrode in terms of distance markers (numbered from 1 to 15)
- **B** ... is the distance between left Voltage Electrode and Controller as well as the distance between Controller and right Voltage Electrode in terms of distance markers (numbered from 1 to 25)

- **L** ... is the number of the current scan point lengthwise. It is related to the lower right corner of your scan field.
- **W** ... is the number of the current scan point crosswise. It is related to the lower right corner of your scan field.
- **D** ... is the current depth at which the measuring takes place.

Detailed information about all available scan modes, scan profiles and how to divide your scan field into scan points you will find in chapter “7 Conducting a measurement” on page 47.

You can exit this screen whenever you like. The current scan point information will be stored and can be used at a later time to continue this measurement.

5.2.2 Continue Measurement

Select this option to see a list of all unfinished measurements. Now find your specific measurement by looking for the previously entered project title.

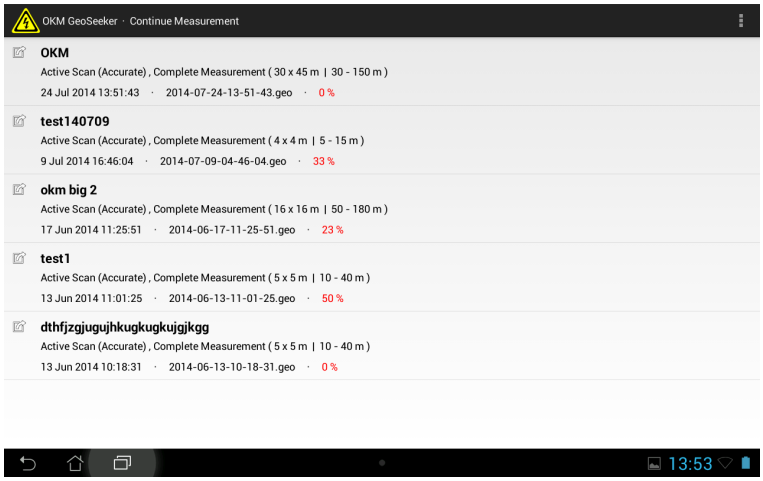

OKM GeoSeeker · Continue Measurement
OKM
Active Scan (Accurate) , Complete Measurement (30 x 45 m | 30 - 150 m)
24 Jul 2014 13:51:43 · 2014-07-24-13-51-43.geo · 0 %
test140709
Active Scan (Accurate) , Complete Measurement (4 x 4 m | 5 - 15 m)
9 Jul 2014 16:46:04 · 2014-07-09-04-46-04.geo · 33 %
okm big 2
Active Scan (Accurate) , Complete Measurement (16 x 16 m | 50 - 180 m)
17 Jun 2014 11:25:51 · 2014-06-17-11-25-51.geo · 23 %
test1
Active Scan (Accurate) , Complete Measurement (5 x 5 m | 10 - 40 m)
13 Jun 2014 11:01:25 · 2014-06-13-11-01-25.geo · 50 %
dthfjzgjugujhkugkugkujgjkgg
Active Scan (Accurate) , Complete Measurement (5 x 5 m | 10 - 40 m)
13 Jun 2014 10:18:31 · 2014-06-13-10-18-31.geo · 0 %
13:53

Figure 5.10: Continue Measurement

After selecting a specific measurement it opens up and you will see all important information as shown in figure 5.9 to setup your electrodes for the next scan point.

If you tap a long time on one of those entries a context menu is opening where you can select one of the following actions:

- **Continue**
  Select this action to continue the unfinished measurement.
- **View**
  Select this action to view the 3d representation of the unfinished measurement.
- **Delete**
  Select this action to delete the selected measurement.

5.2.3 View Measurement

Select this option to see a list of all measurements (finished and unfinished). Now find your measurement by looking for the previously entered project title.

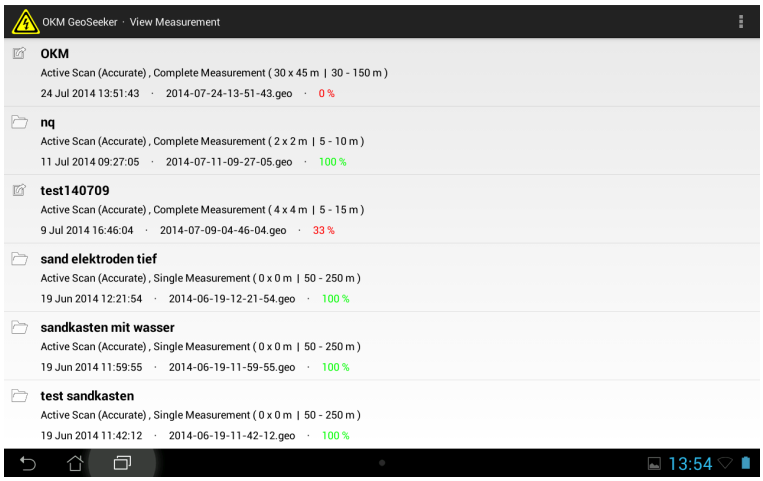

OKM GeoSeeker · View Measurement
OKM
Active Scan (Accurate) , Complete Measurement (30 x 45 m | 30 - 150 m)
24 Jul 2014 13:51:43 · 2014-07-24-13-51-43.geo · 0 %
nq
Active Scan (Accurate) , Complete Measurement (2 x 2 m | 5 - 10 m)
11 Jul 2014 09:27:05 · 2014-07-11-09-27-05.geo · 100 %
test140709
Active Scan (Accurate) , Complete Measurement (4 x 4 m | 5 - 15 m)
9 Jul 2014 16:46:04 · 2014-07-09-04-46-04.geo · 33 %
sand elektroden tief
Active Scan (Accurate) , Single Measurement (0 x 0 m | 50 - 250 m)
19 Jun 2014 12:21:54 · 2014-06-19-12-21-54.geo · 100 %
sandkasten mit wasser
Active Scan (Accurate) , Single Measurement (0 x 0 m | 50 - 250 m)
19 Jun 2014 11:59:55 · 2014-06-19-11-59-55.geo · 100 %
test sandkasten
Active Scan (Accurate) , Single Measurement (0 x 0 m | 50 - 250 m)
19 Jun 2014 11:42:12 · 2014-06-19-11-42-12.geo · 100 %
13:54

Figure 5.11: View Measurement – List of files

After selecting a specific measurement you will see its graphical 3d representation. Opening the measurement can take some time because some additional calculations are processed. After it has been loaded you will see something like shown in figure 5.12.

If you tap a long time on one of those entries a context menu is opening where you can select one of the following options:

- **View**
  Select this action to view the 3d representation of the unfinished measurement.
- **Delete**
  Select this action to delete the selected measurement.

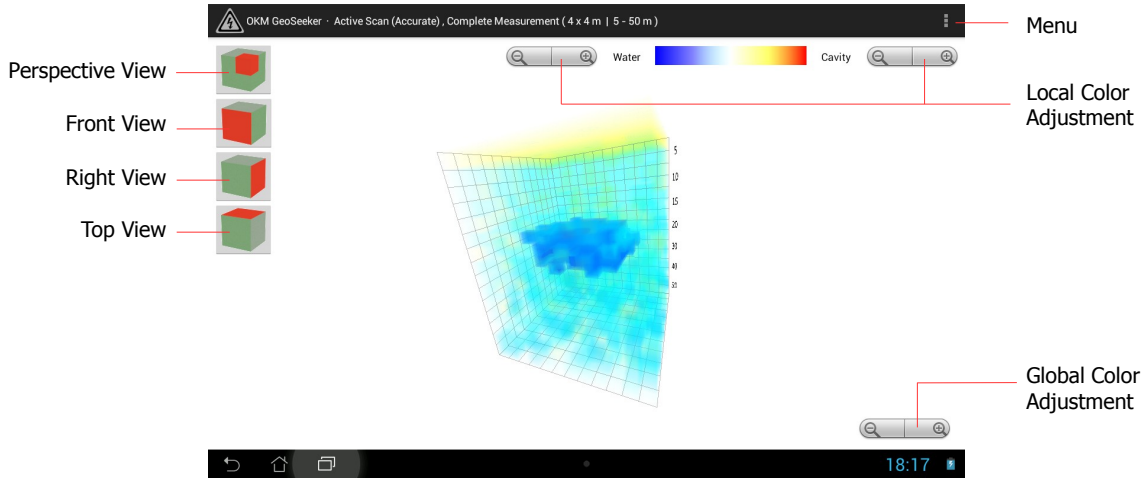


Figure 5.12: View Measurement - 3d representation

View Buttons: A click on one of these buttons changes the orientation of the 3d graphic within the viewport. You may also change the orientation by rotating it with your fingers. Just tap your finger on the screen and swipe over it. You may also zoom in and out by using 2 fingers simultaneously.

Menu: Use this menu to change the measure units (meter or feet) of your application. Furthermore you have access to the previously entered project information.

Local Color Adjustment: The local color adjustment buttons are used to increase or decrease the visibility of blue or red colors. By using these buttons you can highlight a specific color and its representing data.

Global Color Adjustment: The global color adjustment buttons are used to increase or decrease all colors at once.

Depending on the color distribution you will decide about the existence of water or cavity. The more solid color the higher the probability of an existence. Detailed information about graphical analysis of a measurement you will find in chapter “8 Analyzing a Measurement“ on page 61.

5.2.4 Activation

Before you can use the application with your GeoSeeker you have to activate both your Controller and the Power Box with a proper activation code.

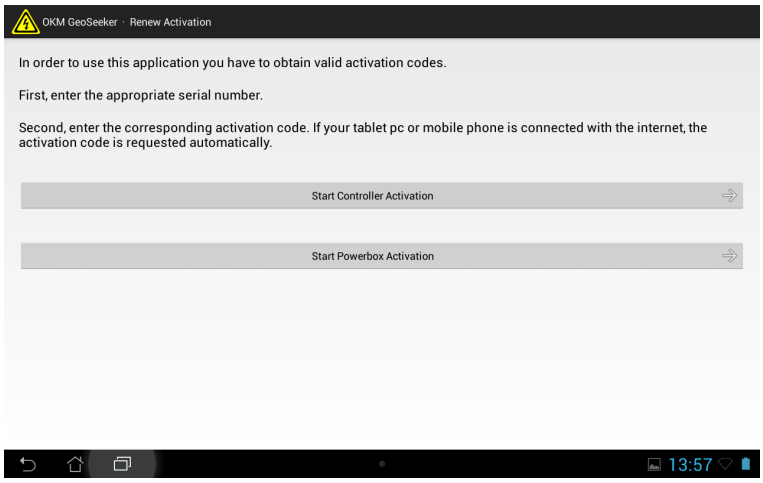

OKM GeoSeeker · Renew Activation
In order to use this application you have to obtain valid activation codes.
First, enter the appropriate serial number.
Second, enter the corresponding activation code. If your tablet pc or mobile phone is connected with the internet, the activation code is requested automatically.
Start Controller Activation
Start Powerbox Activation
13:57

Figure 5.13: Activation

Tap on "Activation" and follow the instructions on your Tablet PC to activate your Controller as well as your Power Box. Without a proper activation you cannot create any new measurement.

First you have to enter the serial number of your Power Box/Controller and after that you have to enter the corresponding activation code as printed on your activation card.

5.2.5 Support Information

Select this option to get more information about OKM's contact details as well as the firmware version of your equipment.

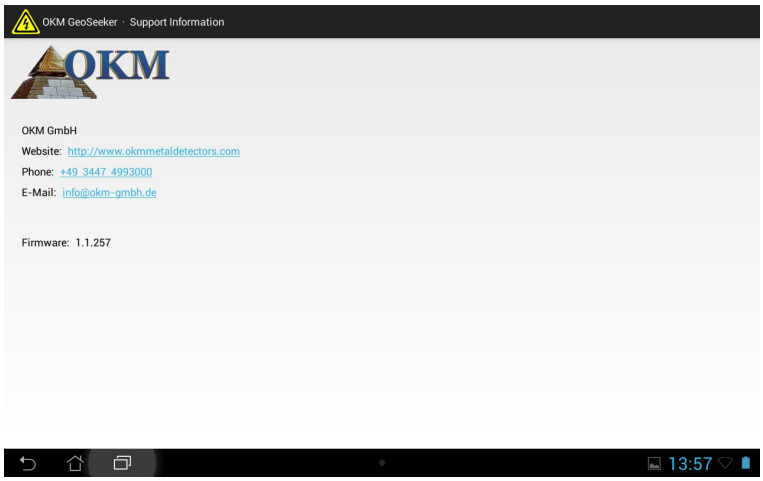


Figure 5.14: Support Information

This version number can be useful for our support team in case you need any technical support.

Chapter 6

Preparing and maintaining the equipment

In this section you will learn more about the preparation and maintenance of your equipment before starting a new measurement.

Before you are going to conduct a new measurement or to continue a previously interrupted measurement you have to make sure that all your equipment is intact and ready to use. Check all cables and connectors for possible damages, recharge all batteries and take care you have enough spare batteries if necessary. Also ensure that no parts are missing before going to your scan field. Keep your equipment always clean and dry.

6.1 Preparing the Controller

6.1.1 Placing and charging the batteries

Place 8 AA batteries into the Controller's battery compartments. Please pay attention to the right polarity of the batteries. The correct polarity is indicated inside of each compartment.

Figure 6.1: Placing batteries into the Controller's compartments

If you have already placed batteries into the compartments and want to recharge it using the supplied charger, ensure that you are only using boost, quick or fast chargeable NiMh batteries or primary cells with a minimum capacity of 2000 mAh or higher.

Danger of Explosion !!!
Never recharge alkali, zinc carbon or lithium batteries / primary cells.

Connect the supplied charger with the Controller to recharge the batteries within the compartments as shown in figure 6.2.

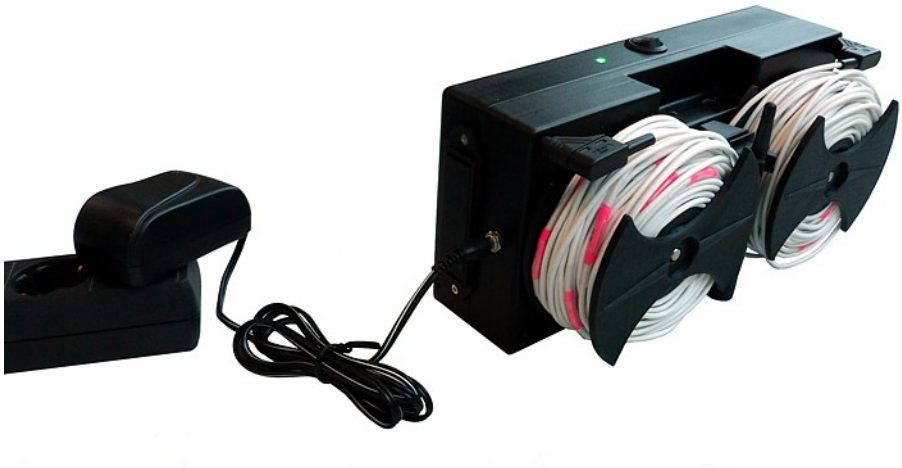


Figure 6.2: Connecting the Controller's charger

As long as the charger is connected to the Controller the charging process takes place no matter if the Controller is powered on or off. But only if the Controller is powered on you will also see the charge condition visually as follows:

- **Power LED blinks red:** Charging in progress
  In case the Power LED is blinking red after more than 5 hours of charging the batteries are defective and have to be replaced.
- **Power LED blinks green:** Charging finished **OR** No batteries in compartments
  If the batteries are completely empty but the Power LED is blinking green after only a short time (less than 1 hour) the batteries are exhausted and have to be replaced.

You may also use one way non-rechargeable NiCd or zinc carbon batteries as well as NiMh batteries with less than 2000 mAh but this will result in much shorter operating times. Also keep in mind not to connect the charger if non-chargeable batteries are placed into the compartments (danger of explosion).

6.1.2 Mounting the Tablet PC holder

If you like to mount the Tablet PC holder to the Controller just put it into place and fix the Tablet PC as shown in figure 6.3 and described in section “4.4 Tablet Holder” on page 23.

Figure 6.3: Tablet PC mounted to Controller

6.1.3 Mounting the Voltage Cable Drums

For the measurement itself two Voltage Cable Drums have to be mounted to the Controller. This is done by pushing the drums over the metallic connectors as shown in figure 6.4.

Figure 6.4: Voltage Cable Drums mounted to Controller

Please ensure that the metal connectors are all clean to have good electrical contact with the drum's inner connectors. While replacing the electrodes during a measurement you may detach the cable drums but as soon as you are ready to measure some new scan values you have to connect it back to the

Controller.

6.2 Preparing the Power Box

6.2.1 Charging the internal batteries

There are two lead acid batteries built-in into the Power Box for the power injection process. Please ensure that this batteries are charged completely before conducting a measurement. For charging you have to connect the supplied charger with the Charger Socket of the Power Box as shown in figure 6.5.

Figure 6.5: Connecting the Power Box Charger

The current charge condition is indicated by the Charger LED of the Power Box, whereas the following indications are possible:

- **Charger LED shines red:** Charging in progress
- **Charger LED shines green:** Charging finished

As soon as the Charger LED shines green the charging process has finished and you can disconnect the charger.

Do not power on your Power Box while charging.

This would interrupt your charging process.

6.3 Creating a Wi-Fi Connection

Before you can use your GeoSeeker for the first time you have to create a Wi-Fi (WLAN) connection between your Tablet PC and Controller. If you purchased the Tablet PC with your GeoSeeker it has been already prepared and you should be able to start your measurement right away.

If there are other public networks available and your Controller is not powered on it might be possible that your Tablet PC is establishing a connection to other networks first.

In case you have to create a new network connection by yourself, you have to use the Wi-Fi capabilities of your Android Tablet PC. Please follow these steps to create your Wi-Fi connection:

1. Power on your Controller
2. Power on your Tablet PC and go to “Settings”.
3. Enable “Wi-Fi” by setting it from “OFF” to “ON”. Now your Tablet PC is looking for available networks automatically. If successful you will see a network called “OKM_GeoSeeker” in your list of available networks.

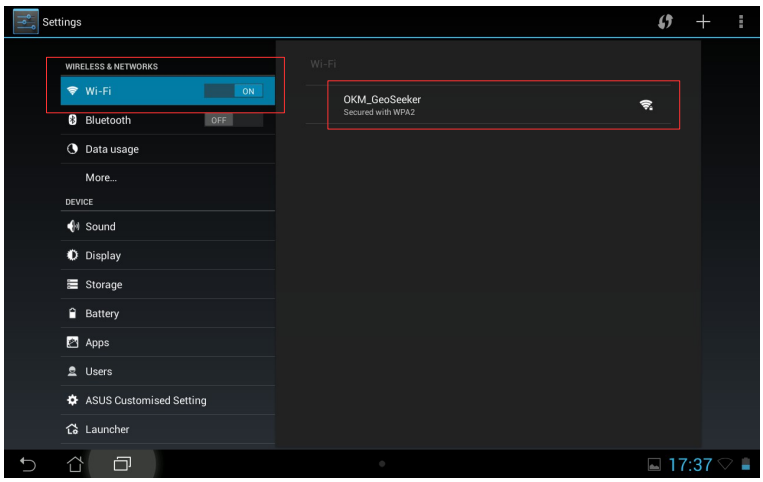


Figure 6.6: Enabling Wi-Fi

4. Select “OKM_GeoSeeker” and enter the network password “GeoSeeker” (use correct upper and lower case). Confirm by tapping “OK”.

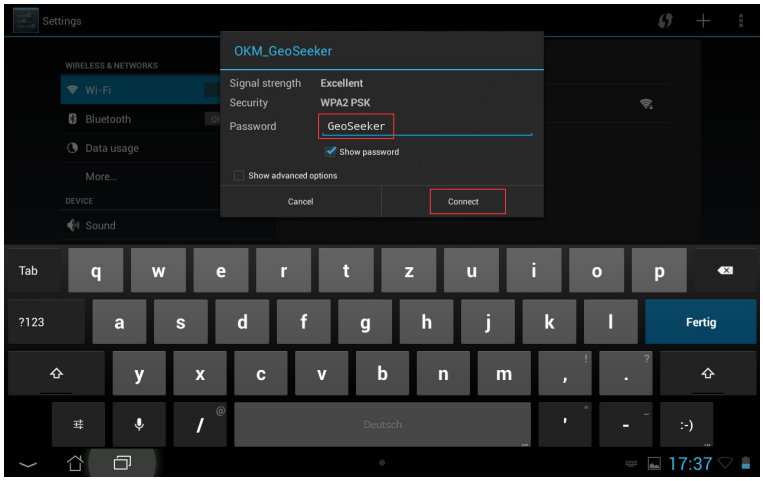


Figure 6.7: Entering Wi-Fi password

5. Now the connection to the Controller is established and you are ready to conduct a new measurement.

This Wi-Fi connection is now stored on your Tablet PC and will reestablish automatically if it is in range unless you connect to another network manually or the Tablet PC is connecting to any other public network.

Chapter 7

Conducting a measurement

In this section you will learn how to conduct a measurement with GeoSeeker.

The GeoSeeker is a geoelectrical measuring instrument and thus intended to measure the resistivity of underground layers. The conductivity of different layers can be used to find potential places of water deposits or cavity. The quality of your measured data depends strongly on the accuracy of your conducted measurement.

Before conducting a measurement read the information from chapter “6 Preparing and maintaining the equipment” on page 39!

7.1 Basic Information

Before you are going to set up a new measurement you have to investigate about your specific scan area. There are some important aspects you have to be aware of before starting your measurement.

- If you are scanning for cavities the overlying layers must not be too wet otherwise the injected power will not reach its final depth. The injected power always uses the easiest and most conductive way to flow through the underground soil.
- Never conduct a measurement during or directly after a thunderstorm. Lightning strikes are not only influencing your measurement, they are also very dangerous while laying out the cables and putting the electrodes into the ground.
- When conducting a measurement the surface of your scan field should be equally dry and not wet. So it will be a bad idea to run a measurement during or directly after rainy days. Wait some days until the ground is not too wet anymore before conducting a measurement.
- The electrodes have to be in good electrical contact with the surrounding soil. The deeper the electrodes are placed into the ground the better the contact and the better the final measuring result.
- The deeper you are scanning the larger the underground objects must be. You cannot detect very small cavities or water deposits at very high depths. It is also much more easy to detect thick objects that overlap more depth layers than flat objects as shown in figure 7.1.

Figure 7.1: Detection of thick objects is better than flat objects

- Your chosen scan field resolution (distance between scan points) must match the object's dimensions. This means you can only detect underground anomalies if you scan right on top of the hidden targets as well as the surrounding ground.

- Additionally it will be a good idea to observe the present vegetation since special plants can indicate the presence of underground water deposits. There also might be areas with more plants or greener plants than others.

7.2 General Measurement Procedure

Before starting any measurement you have to divide your scan field into single scan points. You have to choose a consistent distance (resolution) between your scan points according to your preferred accuracy. The more scan points the better your final scan image but the more time you have to invest into your measurement. Later, during your measurement, you will collect measure values at each of those scan points from certain depths.

It is a good practice to mark each of that scan points with some kind of marker (flag, stick, color point, stone, etc.) to speed up the final measurement. So you have to measure the distances between the scan points only once during the preparation of your scan field and you can move your equipment from point to point easily afterwards.

In figure 7.2 you can see an exemplary scan field with 3 x 3 scan points. The lengthwise as well as the crosswise distance between the scan points is all the same.

Figure 7.2: Dividing the field into scan points and setting up markers

At each of this marked scan points electrical power is injected into the ground using the two Power Electrodes (electrodes with red socket) and the resulting voltage is measured with the two Voltage Electrodes (electrodes with black socket). By increasing (or decreasing) the distance of the Power Electrodes step by step the measure depth also increases (or decreases) accordingly, as shown in figure 7.3.

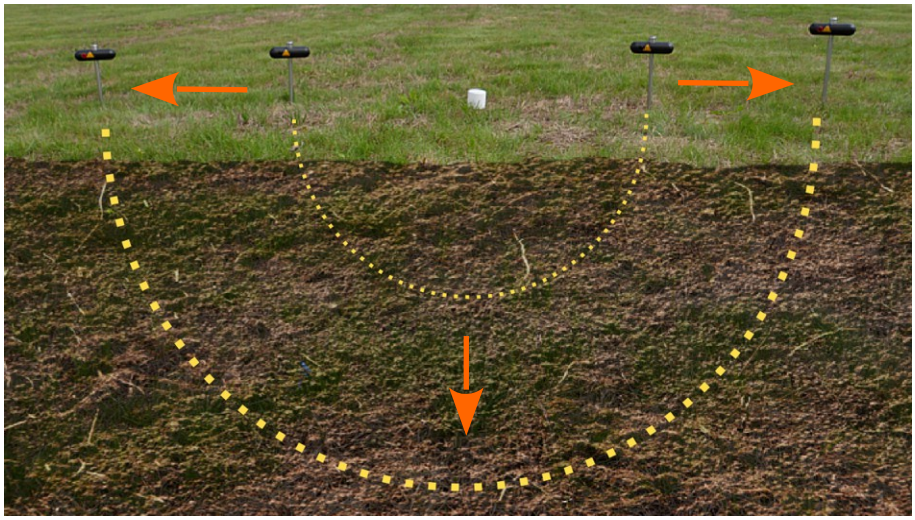


Figure 7.3: Power injection depth depends on electrodes distance

You have to keep in mind that for a maximum depth penetration of 250 m (820 ft) you will also need 250 m (820 ft) free space to the left and right of your scan point to put your electrodes into the ground. So it can be possible that you cannot always scan up to 250 m if there is no free space for your electrodes.

Before starting the actual measurement you have to investigate your area to find out what kind of measurement would work the best and what parameters are useful. While creating a new measurement with the Android application you have to set up several settings regarding scan mode, scan profile, depth range as well as field dimensions.

The GeoSeeker supports different scan modes, which are shown in figure 7.4.

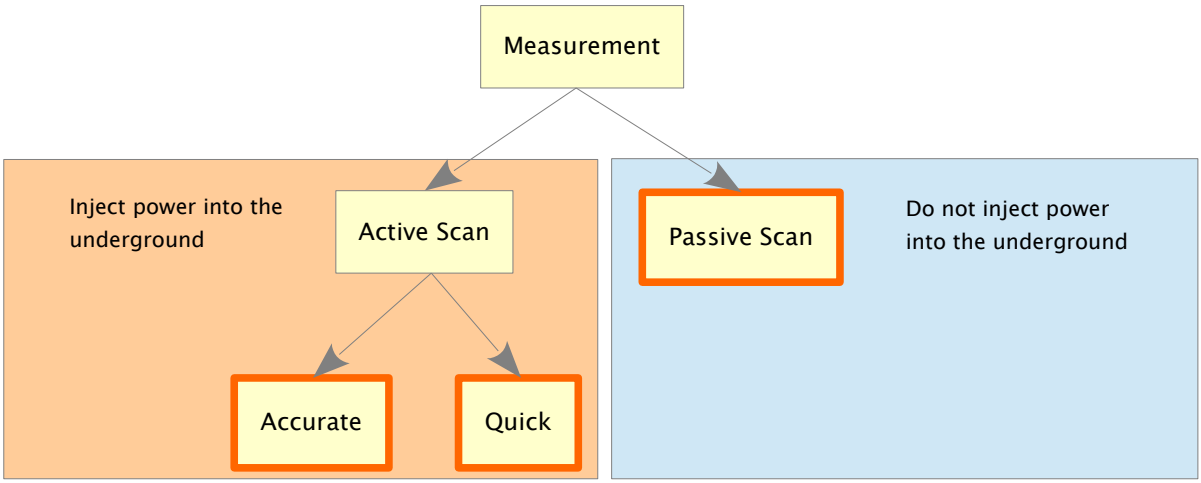
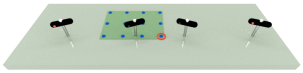


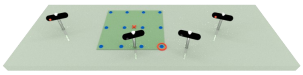
Figure 7.4: Available Scan Modes

An active measurement is always injecting electrical power into the underground before measuring the voltage between the Voltage Electrodes whereas a passive measurement is only detecting natural voltage without any power injection.

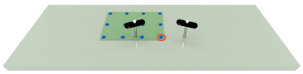
Here are the main differences of the mentioned scan modes:



- **Active Scan (Accurate)**
  This is the “standard” and most recommended operating mode for the GeoSeeker. It is the most accurate and complete scan mode. Power is injected into the underground and all 4 electrodes are being moved from scan point to scan point. The Power Electrodes' reference point is always the current scan point. You may utilize the complete depth range between 5 and 250 m (16 ft – 820 ft).

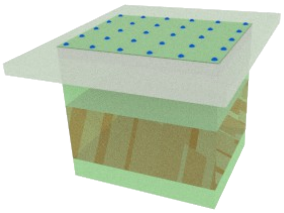


- **Active Scan (Quick)**
  This is a quick version of the accurate scan mode with some limitations concerning depth and field dimensions. Power is injected into the underground but only the Voltage Electrodes are being moved from scan point to scan point. The Power Electrodes' reference point is always the center of the scan field. You may utilize a depth range between 50 and 250 m (33 ft – 820 ft).

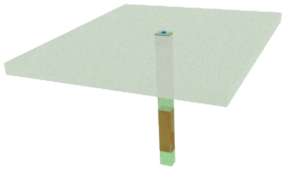


- **Passive Scan**
  This is the quickest scan mode without injecting power into the ground and most useful for sloping areas where flowing water is expected underground. This scan mode is not intended for cavity detection. There is no depth range available.

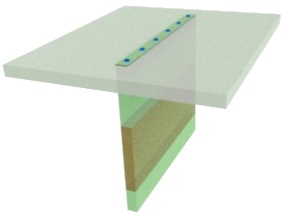
For the active scan modes there are additional scan profiles available:



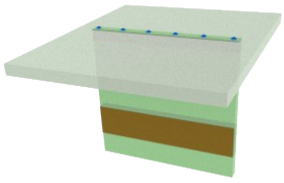
- **Complete Measurement**
  This option is used to measure a complete rectangular field starting with at least 2 x 2 scan points. As the name already indicates, this is the most complete measurement to get data of a large area.



- **Single Measurement**
  This option is used to measure a single scan point only. This is mostly used to do some quick test measurements on your scan field to find potential places where you could do a more complex measurement.



- **Lengthwise Measurement**
  This option is used to measure a single line of scan points lengthwise. Use this option if you would like to scan a cross section in lengthwise direction.



- **Crosswise Measurement**
  This option is used to measure a single line of scan points crosswise. Use this option if you would like to scan a cross section in crosswise direction.

The final amount of scan points (except for the single measurement profile) can be defined during the next steps of the measurement creation. After selecting the operating mode “New Measurement” from the GeoSeeker application you will select a scan mode, a scan profile, set up the starting and ending depth, adjust your field dimensions (length and width) as well as the scan point distance (resolution).

Also read section “5.2.1 New Measurement” from chapter “5 Android Application“ on page 29 for more details and figures concerning this operating mode.

After setting up your measurement your Tablet PC shows the initial setup of your electrodes. An example is shown in figure 7.5.

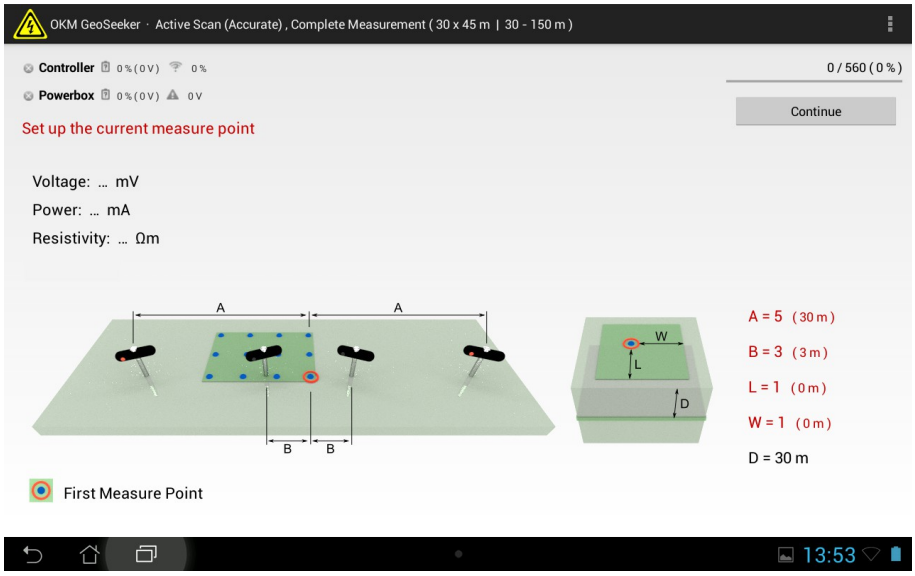

OKM GeoSeeker · Active Scan (Accurate) , Complete Measurement (30 x 45 m | 30 - 150 m)
Controller 0 %(0 V) 0 %
Powerbox 0 %(0 V) 0 V
0 / 560 (0 %)
Continue
Set up the current measure point
Voltage: ... mV
Power: ... mA
Resistivity: ... Ωm
A
A
B
B
W
L
D
A = 5 (30 m)
B = 3 (3 m)
L = 1 (0 m)
W = 1 (0 m)
D = 30 m
First Measure Point
13:53

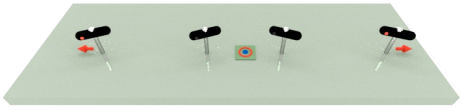
Figure 7.5: Instruction screen for setting up a measurement

You will now arrange all your equipment according to these instructions. For our example it will be as follows:

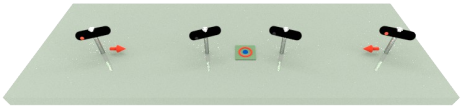
- **A** ... In this example each Power Electrode has to be placed in a distance of 30 m to the left and right of the Power Box. This corresponds to the cable marker “5”. So you will unroll your cable until the marker “5” is reached and then you put the electrode into the ground.
- **B** ... In this example each Voltage Electrode has to be placed in a distance of 3 m to the left and right of the Controller. This corresponds to the cable marker “3”. So you will put the electrode at cable marker “3” into the ground.
- **L, W** ... If you stay in front of your first scan point during a complete measurement you will see scan point markers straight ahead as well as to the left. To find the current scan point in this example just walk “L = 1” scan point markers straight ahead and then “W = 1” scan point markers to the left. Now you will stay at the current scan point.
- **D** ... In this example we are going to measure data in a depth of 30 m when pressing the button “Continue”.

For all coming steps you will simply follow the instructions on your Tablet PC. After each measuring process the application will show you how to replace the electrodes in the field before measuring the next scan point.

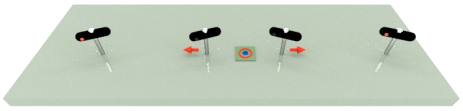
The following instruction scenarios might occur during your measurement:



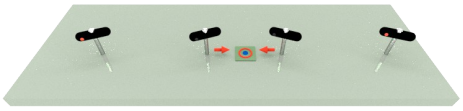
- You have to move the Power Electrodes (red socket) outwards to the next cable marker. This will increase the depth of the current scan point.



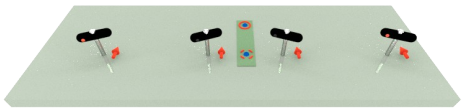
- You have to move the Power Electrodes (red socket) inwards to the previous cable marker. This will decrease the depth of the current scan point.



- You have to move the Voltage Electrodes (black socket) outwards to another cable marker (several cable markers might be skipped). This will be necessary if the measured voltage is too low.



- You have to move the Voltage Electrodes (black socket) inwards to another cable marker (several cable markers might be skipped). This will be necessary if the measured voltage is too high.



- Depending on your scan mode you have to move the Voltage Electrodes (black socket) and/or the Power Electrodes (red socket) to the next or previous scan point.

After recording all measured values in all scan points the application will display a message that your measurement has been completed. Now you can open this measurement by using the operating mode “View Measurement” in your Android application to see a graphical 3d representation of your scan.

7.3 Setting up a measurement

While preparing your measurement you will set up your scan point markers, place the Power Box and the Controller at its initial position and put the electrodes into the ground as indicated by the GeoSeeker application.

Please follow these basic steps to prepare your measurement:

1. Investigate your scan field and find out what kind of measurement you are going to process.
2. Prepare your application and create a new measurement.
3. Prepare your scan field with scan point markers according to your settings in the application.
4. Place the Controller at the first scan point (lower right corner) and put the Voltage Electrodes according to the application instructions into the underground.
5. Place the Power Box according to your selected scan mode and put the Voltage Electrodes according to the application instructions into the underground:
   a) In “Active Scan (Accurate)” the Power Box needs to be placed at the first scan point.
   b) In “Active Scan (Quick)” the Power Box needs to be placed in the center of the scan field.
   c) In “Passive Scan” the Power Box is not used at all.
6. Start measuring the first scan point and follow the application's instructions until your measurement has been completed successfully.

7.3.1 Setting up your scan field with markers

After investigating your area you should create a new measurement with your application to define the field dimensions, the scan point distance (resolution) as well as the start depth and end depth.

Then you should place markers at each scan point according to your settings to assure a fluid measuring process. The picture from figure 7.2 on page 49 shows an example of how to mark your scan points.

7.3.2 Setting up the power injection for active scan modes

The power injection equipment consists of the Power Box, the Power Cable Drums as well as the Power Electrodes with Extension Cable. All those parts are equipped with red plugs or red sockets. This Power Line is used to inject electrical power into the underground to generate a potential difference (fall of voltage).

You can skip setting up the Power Line if you are using the passive scan mode. Otherwise follow these steps to set up the Power Line for a measurement:

1. Depending on the selected scan mode place the Power Box
   a) at the current scan point if in “Active Scan (Accurate)”
   b) in the center of your scan field if in “Active Scan (Quick)”

2. Connect the plug of the first Power Cable Drum into the appropriate socket of the Power Box.

3. Unroll the cable of the Power Cable Drum by moving away from the Power Box until you reach the cable marker indicated by the Android application of your Tablet PC.

4. Put the Power Electrode next to the cable marker into the ground as deep as possible. Use a hammer if necessary.

5. Use the Extension Cable to connect the Power Drum with the Power Electrode.

6. Repeat steps 2 to 5 for the second Power Cable Drum and Electrode.

7.3.3 Setting up the voltage measurement

The voltage measurement equipment consists of the Controller with Voltage Cable Drums as well as the Voltage Electrodes. All those parts are equipped with black plugs or black sockets. This Voltage Line is used to measure the natural voltage (passive scan) or the generated potential difference (active scan) of the Power Line.

1. Place the Controller at the current scan point.

2. Unroll the cable of the first Voltage Cable Drum completely by laying it out in a straight line.

3. After reaching the end make a U-turn and bring back the cable to the cable marker indicated by the application of your Tablet PC. Unrolling the cable completely is necessary to get the right order of the cable markers and makes it easier to rearrange the electrodes afterwards.

4. Put the Voltage Electrode next to the cable marker into the ground as deep as possible. Use a hammer if necessary.

5. Connect the cable of the Voltage Cable Drum with the Voltage Electrode.

6. Repeat steps 2 to 5 for the second Voltage Cable Drum and Electrode.

7.3.4 Final connection schemas

At this point you will see the complete setups of different scan modes to get a better idea how the final preparation has to look like.

7.3.4.1 Active Scan (Accurate)

During an Accurate Active Scan all electrodes have to be arranged around the current scan point (see figure 7.6). So all electrodes are in one straight line to each other.

Figure 7.6: Arrangement of electrodes during Active Scan (Accurate)

7.3.4.2 Active Scan (Quick)

During a Quick Active Scan only the Voltage Electrodes have to be arranged around the current scan point. The Power Electrodes have to be arranged around the center of the scan field. As shown figure 7.7 the Power Electrodes and the Voltage Electrodes are not in one line but two.

Figure 7.7: Arrangement of electrodes during Active Scan (Quick)

7.3.4.3 Passive Scan

During a Passive Scan only the Voltage Electrodes are used and have to be arranged around the current scan point. The Power Electrodes are not used at all.

Figure 7.8: Arrangement of electrodes during Passive Scan

Chapter 8

Analyzing a Measurement

In this section you will learn how to analyze a measurement by using the Android application.

While scanning an area you will see the measured values (power, voltage and resistivity) of the current scan point on the display of the Tablet PC. Based on that values you can make first conclusions about your scan field conditions.

You always have to take the following aspects into your considerations:

- You always have to inform yourself about the geological structures in your area to know about the underground conditions.
- Soil composition, ground moisture and temperature are influencing the soil resistivity. Soil is rarely homogeneous and the resistivity of the soil will vary geographically and at different soil depths.
- Very low resistivity values are indicating a good conductance, which could indicate a high probability of water deposits.
- Very high resistivity values are indicating a bad conductance, which could indicate a high probability of cavities.

8.1 Interpretation of scan values

There are 3 basic values indicated after each single scan process. So you will get a rough idea about the underground conditions while scanning the area. The measure values are shown in figure 8.1 where you can read the values after measuring a scan point.

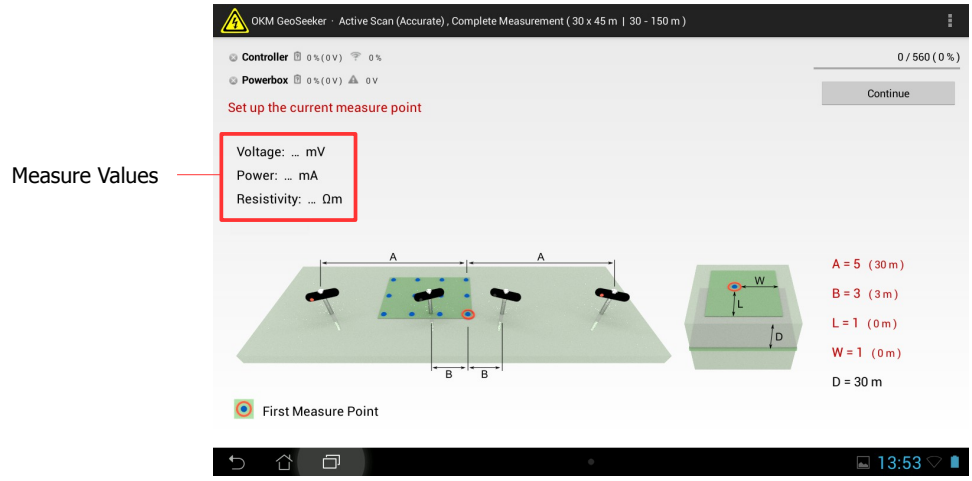


Figure 8.1: Measure values as indicated during a measurement

Some of the measure values will not be available in passive scan mode. The available measure values are:

- **Voltage:** The voltage is measured in Volt (V) and indicates the potential difference measured by the Controller.
- **Power:** The power is measured in Ampere (A) and indicates how much electrical current has been injected into the underground by the Power Box. This value is only available in active scan modes.

- **Resistivity:** The ground resistivity is measured in Ohm-Meter (Ωm) and indicates the resistance of the underground at the current scan point and depth. It is mainly calculated by the power, voltage and distance of the electrodes. This value is only available in active scan modes.

The resistivity value is the basis of further calculations concerning underground water deposits and cavities.

8.2 Interpretation of graphical representations

After completing a measurement you can also generate a 3d graphic of the measured values. The values on which the 3d representation is based on depends on the scan mode of the measurement.

8.2.1 Active Scan

After completing an active scan the 3d graphic is representing the ground resistivity values in different colors, as shown in figure 8.2, to highlight potential places of very high and low conductivity. The color's meanings are:

- **Blue:** This color indicates a high conductivity and a low resistivity as typical for underground water deposits.
- **Yellow / White:** This color indicates a medium conductivity and resistivity as typical for normal underground soil.
- **Red:** This color indicates a low conductivity and a high resistivity as typical for underground cavities or impervious layers.

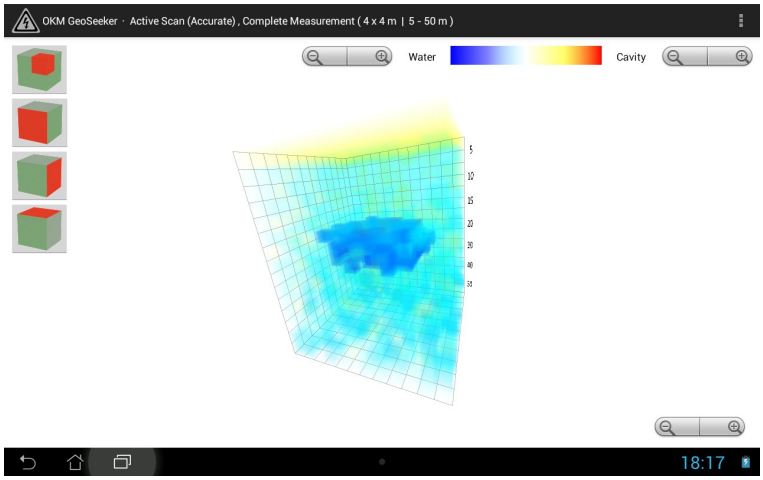


Figure 8.2: Graphical 3d representation of an active scan

After conducting an active scan you will also get some kind of depth estimation. Please keep in mind that the indicated depths are maximum depths only. In most cases the indicated depth is often higher than the real depth might be but it will give you a rough estimation where the objects of your desire may be.

Each cube in the 3d graphic is representing a measure value of your scan field.

8.2.2 Passive Scan

After completing a passive scan the 3d graphic is representing the natural ground voltage values in different colors as shown in figure 64.

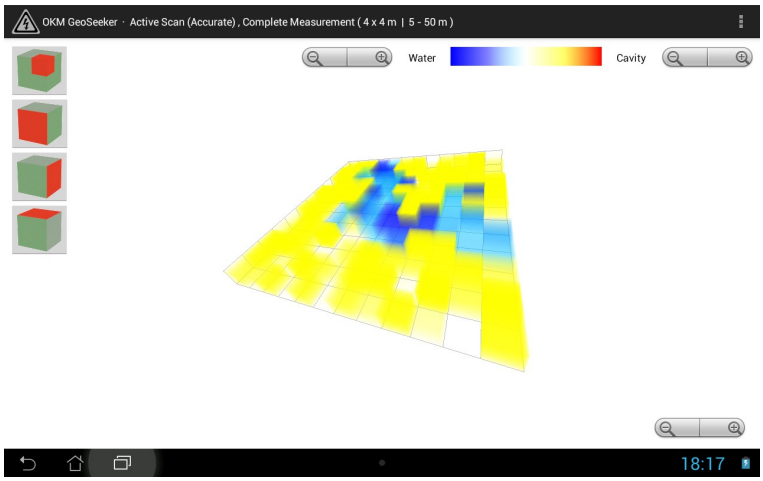


Figure 8.3: Graphical 3d representation of a passive scan

A passive scan is only showing the distribution of the natural occurring voltage. It is not possible to get an estimation of the depth of underground anomalies. Each cube in the 3d graphic is representing a measure value of your scan field.

8.3 Examples

Here you will find some additional examples to get a better understanding of possible values and its representation. Please keep in mind that your own measurements may look different than these graphical representation as your local environment, ground conditions and hidden anomalies may be very different too.

8.3.1 Passive Measurement

The passive measurement contains no depth information and is only showing a plane representing the natural occurring voltage, which could indicate underground flowing water resources.

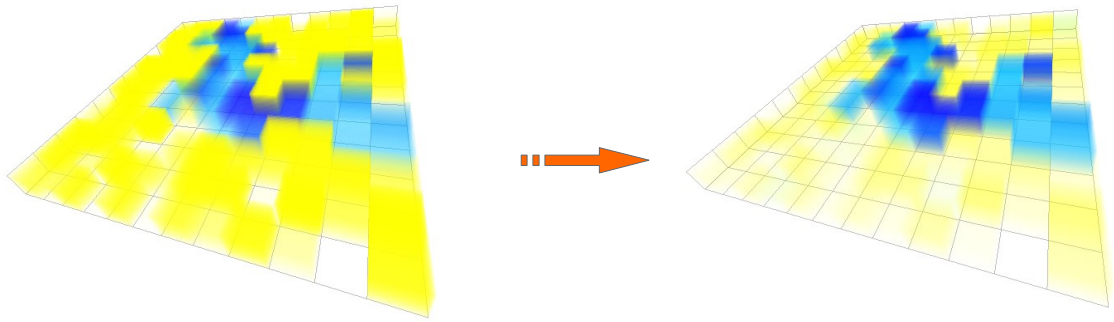


Figure 8.4: Example of a passive measurement – flowing water

After color adjustment the background is reduced and the blue color is better visible.

8.3.2 Active Measurements

8.3.2.1 Water Deposits

The typical color of water deposits is blue. The following 3d graphics are showing an indication of water under the ground.

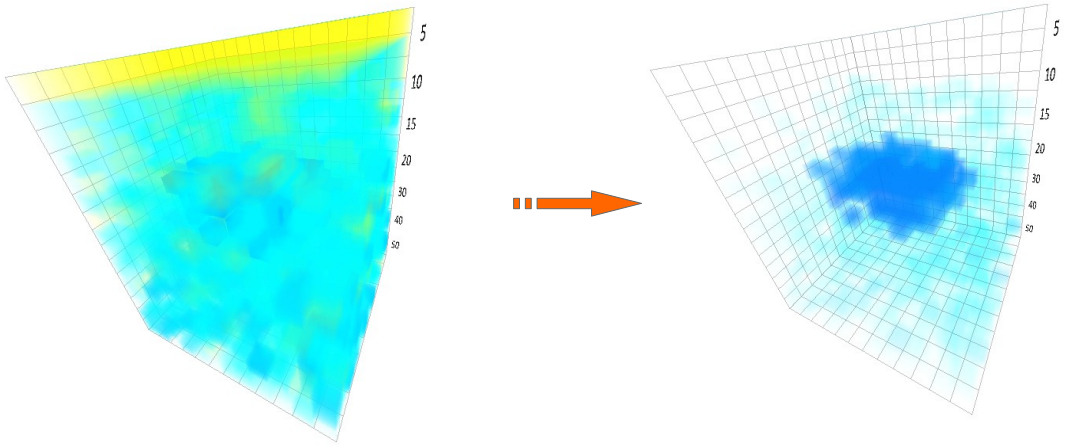


Figure 8.5: Example of an active measurement - water deposit

The initial 3d representation is not that clear because of surrounding measure values. After adjusting the color an underground water deposit is clearly visible.

8.3.2.2 Water deposits with areas of high resistivity

In this example you will find two different kind of anomalies at the same time. There is an area of high resistivity at the top, shown in red and yellow colors. At the bottom of the graphic there is another area of high conductance (very low resistivity), mostly indicating a high probability of a water deposit.

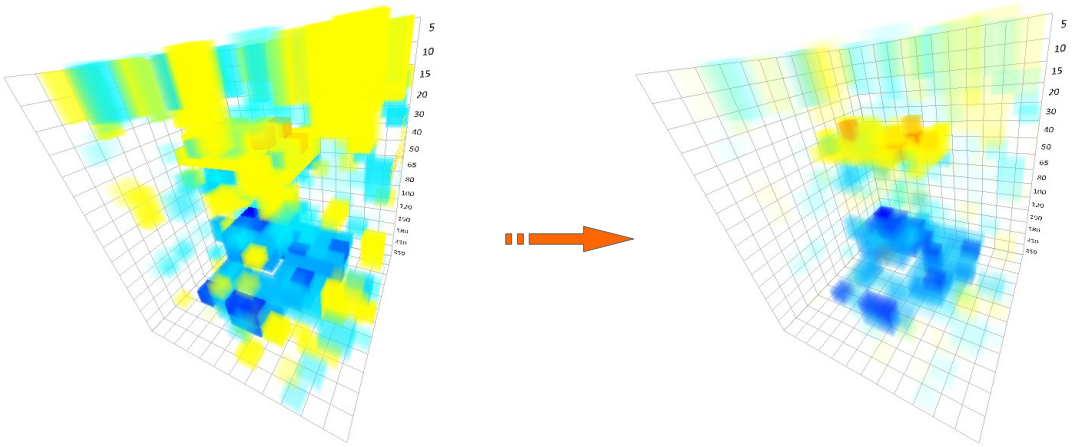


Figure 8.6: Example of an active measurement - water deposit and barrier

In the beginning the 3d representation is not very clear but after adjusting the colors two anomalies become clearly visible.

8.3.2.3 Cavities

Underground cavities (if big enough) are typically shown in reddish colors. Cavities have a very high resistivity as long as it has not been refilled with any conductive material.

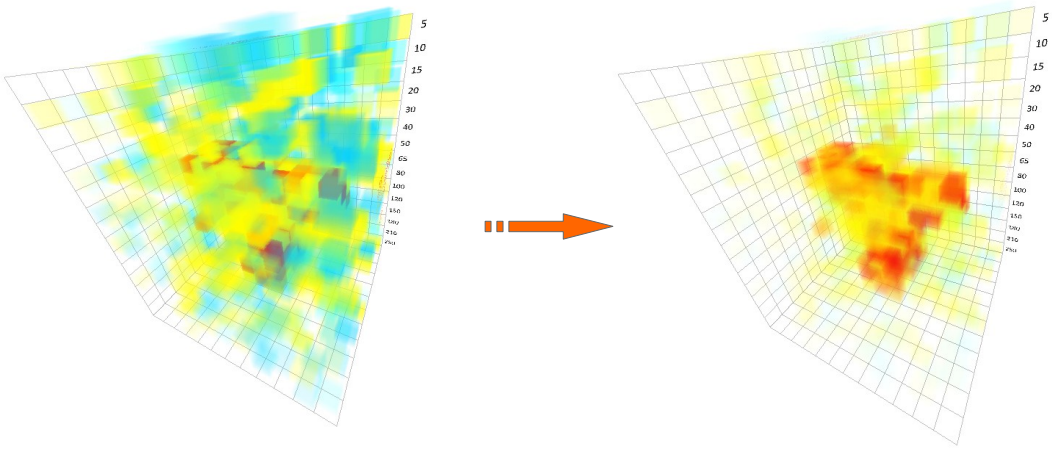


Figure 8.7: Example of an active measurement - cavity

After adjusting the colors you will see there is some type of cave in the measurement.

8.3.2.4 Impervious layers

A typical structure you can see after measuring in mountain areas are impervious layers or barriers under the ground. This layer mostly appears at the transition of loosely soil to massive stone.

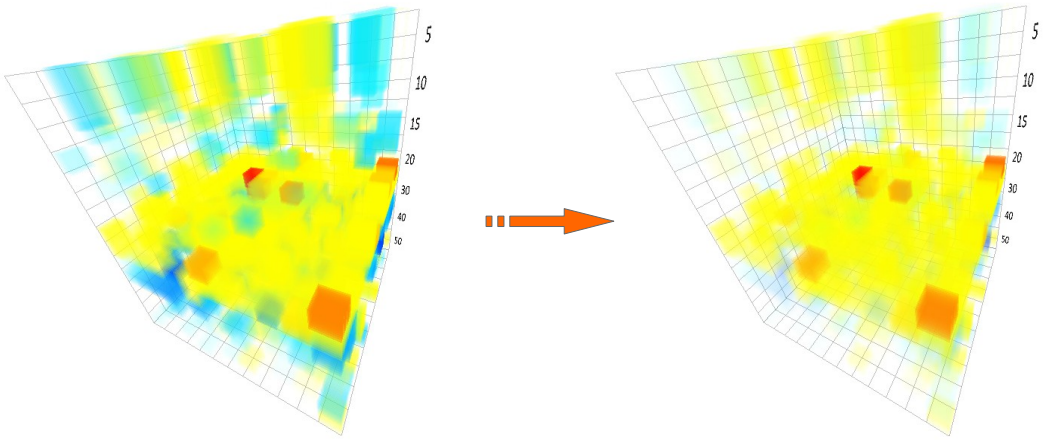


Figure 8.8: Example of an active measurement - impervious layer / barrier

After adjusting the colors it is very obvious that there is a complete layer in the measurement with high resistivity.

Chapter 9

Tips and Tricks

In this section you will get some additional tips you should consider during your measurements.

9.1 Improving your scan results

There are some aspects to keep in mind for improving the results of your scanning process. Please pay attention that the electrodes have good electrical contact with the surrounding ground. Therefor it is necessary to put the electrodes as deep as possible into the underground, as shown in figure 9.1.

Figure 9.1: Electrodes need good electrical ground contact

Even if you cannot put all electrodes very deep into the ground all electrodes needs to be placed in the same depth as shown in figure 9.2.

Figure 9.2: Electrodes have to be equally set into the ground

Only then an equal electrical distribution is guaranteed.

9.2 Speeding up your measurement

The electrodes have to be replaced a lot while conducting a measurement. This is really tough when you are operating the device just by yourself. So it is strongly recommended to work in a group of 3 or better 5 people.

9.2.1 Operation with 3 people

The first person is responsible to operate the Tablet PC with the Android application. Furthermore this person adjusts the inner Voltage Electrodes (black socket).

Figure 9.3: Operating the GeoSeeker with 3 people

The other two persons are responsible for the adjustment of the Power Electrodes (red socket). So each of that two persons has control over a Power Cable Drum. One to the left and the other one to the right. Both persons rearrange the electrodes according to the instructions of the first person who operates the Controller. It is very recommended to use 3 walkie-talkies to give instructions because the distance to the operator can be up to 250 meters (depending on the depth settings).

Make sure each participant knows about the possible danger of high voltage.

9.2.2 Operation with 5 people

This situation is similar to the previous one but there are two additional persons responsible for the Voltage Electrodes (black socket) which are connected to the Controller.

Figure 9.4: Operating the GeoSeeker with 5 people

So finally there is one person per electrode and the operator of the Tablet PC is only giving instructions and takes care about the whole scanning process.

Make sure each participant knows about the possible danger of high voltage.

9.3 Measurements under tough soil conditions

Some environmental conditions make it really hard to conduct a resistivity measurement. There can be really tough situations like

- very dry soil or sand and
- very hard rock.

But there are also some ways to measure the ground resistivity in that kind of environments.

Sometimes it is not possible to push the electrodes into the ground with bare hands. Then you should use a hammer. But on really hard rock even that is not possible and you need more helpful tools like a drilling machine. First drill a hole into the hard underground before placing the electrode. After that the hole needs to be refilled with wet sand or other good conductive soil to create a good electrical contact to the surrounding environment as shown in figure 9.5.

Figure 9.5: Drilling a hole and refilling it for the electrode

If you are working on really dry soil like sand you should use some water (better salt water) and just give a little splash (small cup) over each electrode shaft to improve the electrical ground contact. You have to assure that you water all electrodes with the same amount of water. This procedure has to be repeated each time after replacing the electrodes.